FAILURE DIAGNOSIS METHOD OF VEHICLE COMMUNICATION NETWORK

CROSS REFERENCE TO RELATED APPLICATION

This application is based upon and claims the benefit

5 of Japanese Patent Application No. 2003－23647 filed on January 31, 2003, the content of which are incorporated herein by reference.

FIELD OF THE INVENTION

10 The present invention relates to a failure diagnosis method of a communication network for a vehicle that is formed by a plurality of electronic control instruments and electronic control devices that are mounted on a vehicle such as an automobile, being connected to a

15 multiplex communication line.

BACKGROUND OF THE INVENTION

A related art is disclosed in Japanese Patent Publication 2002-91549 which is a failure diagnosis device

20 of an electronic control system for a vehicle. This failure diagnosis device has a signal analysis portion for analyzing communication signal information that is received through an input portion provided in the failure diagnosis device from a multiplex communication line to

25 which a plurality of electronic control related members are connected.

The signal analysis portion includes a first failure region identification portion that identifies an area with a possibility of failure in a multiplex communication system such as a sensor failure, or the like based on whether or not communication is performed by the plurality of electronic control related members using the received communication signal information; and a second failure region identification portion that identifies an electronic control related member with a possibility of failure out of the plurality of electronic control related members based on data contents of the communication signal that is obtained from the communication signal information.

Accordingly, it is possible to identify the area with a possibility of failure in the multiplex communication system, and the electronic control related member with a possibility of failure out of the plurality of electronic control related members.

However, in the related art as disclosed above, for example, when it is determined that there is an abnormality with the multiplex communication system, the abnormality portion of the multiplex communication system cannot be identified. That is, the first failure region identification portion performs failure diagnosis for the entire multiplex communication system. Therefore, only a board failure region such as a sensor failure, or the like can be identified, and a determination cannot be made what

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kind of abnormalities has occurred at which portion of the multiplex communication system. (It is not possible to determine whether an abnormality has occurred in a main line of the multiplex communication line, or a branch line

5   that is wired from the main line to the electronic control related members, and in the latter case at which a branch line abnormality has occurred.)

SUMMARY OF THE INVENTION

10   The present invention is made in view of the foregoing circumstances, and it is an object of the present invention to provide a failure diagnosis method of a communication network for a vehicle that is easily capable of identifying an abnormality portion when failure

15   (abnormality) occurs in the communication network.

According to the present invention, when failure has occurred in an electronic control instrument and when an abnormality including disconnection or short circuit has occurred in the communication line from a main line to a

20   branch line that is connected to the electronic control instrument of the multiplex communication line, different diagnosis trouble codes are stored at the failure diagnosis portion of an electronic control device of the present invention. Further, a resistance value of the

25   main line of the multiplex communication line is measured, and an abnormality portion in the communication network is identified by a combination of the measured resistance

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value of the main line and the diagnosis trouble code that is stored in a failure diagnosis portion.

When an abnormality such as disconnection, short circuit, or the like has occurred in the main line or the branch line that is connected from the main line to the electronic control instrument of the multiplex communication line, main line resistance of the multiplex communication line differs depending on the abnormality portion thereof. Furthermore, when an abnormality has occurred, if the code that differs depending on an abnormality state is stored in the failure diagnosis portion, failure state is identified. For this reason, depending on the combination of the resistance value of the main line resistance and the diagnosis trouble code, disconnection of the main line of the multiplex communication line, disconnection of the branch line that is connected from the main line to the electronic control instrument, short circuit of the main line, the short circuit of the branch line, or the like can be identified.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features and advantages of the present invention will be understood more fully from the following detailed description made with reference to the accompanying drawings. In the drawings:

FIG. 1 is a schematic diagram of a communication network for a vehicle;

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FIG. 2 is a table of diagnosis trouble codes;

FIG. 3 is a diagram showing a relationship between resistance values of a CAN bus main line and abnormality portions; and

5   FIG. 4 is a drawing showing a combination pattern of the resistance values, diagnosis trouble codes and abnormality portions.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

10   The present invention will be described further with reference to various embodiments in the drawings.

An embodiment of the present invention will be explained referring to drawings.

FIG. 1 is a schematic diagram of a communication

15   network for a vehicle.

The embodiment is applied to a system (hereafter referred to as a vehicle stability control system for preventing lateral sliding) that controls a behavior of the vehicle so as to ensure stability while the vehicle is

20   turning, for example. As shown in FIG. 1, in this embodiment, a communication network is constructed by various sensors 1, 2 and an ECU 3 being connected to a CAN bus.

The CAN bus, that is a multiplex communication line

25   that carries communication data, includes main line configured with a CAN-H line 4a and a CAN-L line 4b (hereafter referred to as CAN bus main line 4) that are

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connected to two terminal resistance (120Ω in the

embodiment) and a branch line 5 that connects the CAN bus

main line 4 and the various sensors 1, 2 or a diagnosis

tester connection connector 7 that functions as a

5   connector for measurement.

The various sensors 1, 2 are a yaw rate sensor 1 and

a steering angle sensor 2 for detecting vehicle

information, for example. They are connected to a J/C

(junction connector) 6 through each branch line 5, and

10   then connected to the CAN bus main line 4 via the J/C 6.

The ECU 3 is an electronic control device that

controls the vehicle stability control system and

configured from a general micro computer with a memory and

the like. The ECU 3 is connected to the CAN bus main line

15   4, and has a failure diagnosis function (not shown) that

performs a failure diagnosis based on a signal that is

sent from the various sensors 1, 2. The failure diagnosis

function is achieved by a failure diagnosis portion of the

ECU 3. The failure diagnosis portion stores, in the

20   memory, a diagnosis trouble code that differs depending on

the failure state. Specifically, when an abnormality has

occurred in the CAN bus communication, when the various

sensors 1, 2 are malfunctioning, and when an abnormality

such as disconnection or short circuit, or the like has

25   occurred in the communication line from the CAN bus main

line 4 to the branch line 5 that is connected to the

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various sensors 1, 2, the diagnosis trouble code corresponding to each case is stored in the memory.

FIG. 2 shows one example of a correlation between failure states and diagnosis trouble codes. As shown in this figure, diagnosis trouble codes are assigned for each case: U01 is assigned when malfunction in CAN communication occurs, U02 is assigned when malfunction in CAN communication with steering angle sensor 2 occurs, U03 is assigned when malfunction in CAN communication with the yaw rate sensor 3 occurs, C02 is assigned when malfunction in the steering sensor 2 occurs, and C03 is assigned when malfunction in the yaw rate sensor 3 occurs.

Next, a failure diagnosis method of a communication network will be explained.

In the embodiment, when an abnormality (failure) has occurred in the aforementioned communication network, a resistance value of the CAN bus main line 4 is measured, the diagnosis trouble code that is stored in the memory of the ECU 3 by the failure diagnosis portion is confirmed, and an abnormality portion is identified by combining the resistance value and the diagnosis trouble code.

The terminal resistance of 120Ω is provided with the terminal position of the CAN bus main line 4, for example, each terminal portion of the ECU 3 and the J/C 6 as shown in FIG. 1. Therefore, the resistance value of the CAN bus main line 4 is obtained by measuring a resistance value between the CAN-H line 4a and the CAN-L line 4b, that is,

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a resistance value of a synthetic resistance that is formed by the terminal resistance. Specifically, the resistance value of the CAN bus main line 4 is measured by connecting an ohm meter, or the like to the diagnosis tester connection connector 7 that is connected to the CAN bus main line 4.

In this case, when the CAN bus main line 4 is in a normal state, each terminal resistance is connected in parallel to the diagnosis tester connection connector 7. Therefore, the resistance value to be measured is 60Ω. However, when an abnormality such as disconnection, short circuit, or the like has occurred in the CAN bus main line 4 or the branch line 5 (including the branch line 5 that is connected to the diagnosis tester connection connector 7), the resistance value of the CAN bus main line 4 differs depending on the abnormality portion, therefore, the abnormality portion can be identified to some extent depending on the measured resistance value.

On the other hand, the diagnosis trouble code is confirmed by connecting a tester (not shown), or the like to the diagnosis tester connection connector 7, and viewing details that is stored in the memory of the ECU 3 by the failure diagnosis portion. Then, as shown in FIG. 2, since different diagnosis trouble codes (diagnosis codes) are set for an abnormality in the CAN bus communication, failure in the various sensors 1, 2, an abnormality (disconnection or short circuit) in the

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communication line from the CAN bus main line 4 to the

branch line 5 that is connected to the various sensors 1,

2, an abnormality state can be confirmed by checking the

diagnosis trouble code type.

5   Based on these methods, the resistance value of the

CAN bus main line 4 is measured and the diagnosis trouble

code is confirmed, and a failure diagnosis of the

communication network is performed following the diagnosis

procedure a) to b) below.

10   a) First, the resistance value of the CAN bus main

line 4 is measured, and the abnormality portion is

identified depending on the measured resistance value.

        Specifically, a correlation between the resistance

value of the CAN bus main line 4 and a problem portion is

15   set as shown in FIG. 3, based on which the abnormality

portion is identified.   Note that each problem as shown in

(1) to (4) of FIG. 3 has occurred at the portion as shown

in (1) to (4) of FIG. 1.

        Resistance value 120Ω --- disconnection of the CAN

20   bus main line 4

        Resistance value 0Ω --- short circuit of the CAN bus

main line 4, short circuit of the branch line 5, short

circuit of the ECU 3 and the various sensors 1, 2

        Resistance value ∞ --- disconnection of the branch

25   line 5 that is connected to the diagnosis tester

connection connector 7

Resistance value 60Ω --- disconnection of the branch

line 5 that is connected to the various sensors 1, 2

(however, the CAN bus main line 4 is in a normal state.)

Alternatively, failure of the various sensors 1, 2, or the

5   ECU 3.

b) Confirmation is made whether the measured

resistance value is any one of 120Ω, 0Ω, and ∞, or 60Ω.

Then, a procedure for the measured value is selected.

Here, the resistance value of the CAN bus main line 4

10   and diagnosis trouble codes has a relationship as shown in

FIG. 4.   As seen from the figure, when the resistance

value is 120Ω, an abnormality state is such that one of

U01 to U03 has been output as the diagnosis trouble code;

when the resistance value is 0Ω, an abnormality state is

15   such that a set of U01 to U03 has been already output as

the diagnosis trouble code; and when the resistance value

is ∞, a state is such that no diagnosis trouble code has

been output.

For this reason, when the resistance value is 120Ω,

20   0Ω or ∞, it is possible to identify the abnormality state

without confirming the diagnosis trouble code.

However, when the resistance value is 60Ω, it is not

possible to distinguish a case where the CAN bus main line

4 is in a normal state, a case where disconnection has

25   occurred in the branch line that is connected to each

sensor 1, 2 and a case where failure has occurred in the

ECU 3 or the sensors 1, 2 themselves. In this case, it is
necessary to confirm the diagnosis trouble code.

c) Therefore, when the measured resistance values are
120Ω, 0Ω and ∞, the abnormality portions that are
identified are repaired, respectively. That is, when the
resistance value is 120Ω, the CAN bus main line 4 is
repaired, when the resistance value is 0Ω, each of sensors
1, 2 or the ECU 3 is removed one by one so as to identify
and repair the portion of the short circuit, and when the
resistance value is ∞, the branch line that is connected
to the diagnosis tester connection connector 7 is
repaired. Then, the resistance value of the CAN bus main
line 4 is measured once again so as to confirm that the
value shows the normal value of 60Ω.

d) On the other hand, when the measured value is 60Ω
(including a case where the abnormality portion is
repaired in process b) and the resistance value shows a
normal value of 60Ω), the diagnosis trouble code is
confirmed by a tester. Here, if the diagnosis trouble
code is not displayed on the tester, the state is regarded
as "no abnormality in particular", and the failure
diagnosis is completed.

When the measured resistance value is 60Ω, and if
the diagnosis trouble code related to the communication
line is displayed, the abnormality portion is identified
by the diagnosis trouble code (in this case, it is assumed

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that the branch line that is connected to the various
sensors 1, 2 is disconnected).

In addition, other than diagnosis trouble codes
related to the communication line, when the diagnosis
5   trouble code related to the sensors 1, 2 such as C01, C02,
or the like as shown in FIG. 2, it is possible to identify
the failure of the sensors 1, 2 corresponding to the
diagnosis trouble code.

As described above, when an abnormality (failure) has
10   occurred in the communication network, by combining the
resistance value of the CAN bus main line 4 and the
diagnosis trouble code that is stored in the failure
diagnosis portion of the ECU3, it is possible to
distinguish an abnormality (disconnection or short
15   circuit) in the CAN bus main line 4, an abnormality
(disconnection or short circuit) of the branch line 5, or
failure of the various sensors 1, 2 themselves.
Accordingly, the abnormality portion in the communication
network can be identified within a short period of time,
20   thereby significantly reducing repair time.

In addition, according to the aforementioned method,
the abnormality portion can be identified only by
combining the resistance value of the CAN bus main line 4
and the diagnosis trouble code. Therefore, a need for
25   providing another circuit for identifying the abnormality
portion is eliminated, and the failure diagnosis for the

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communication network using the CAN bus (multiplex

communication line) can be achieved with a low cost.

(Example of modification)

In the aforementioned embodiment, it is described

5   that an example where the resistance value of the CAN bus

main line 4 is measured by the ohm meter. However, a

function of measuring the resistance value may be provided

with the tester that reads the diagnosis trouble code from

the ECU 3. In this case, it is possible to realize a

10   complete automatic failure diagnosis by the tester.

Moreover, if the aforementioned diagnosis procedure

is programmed into the tester (a tool other than the

tester is also acceptable), and a tester can be enabled to

display the procedure, a user can perform the diagnosis

15   method in accordance with the procedure displayed on the

tester. Therefore, an interactive type automatic failure

diagnosis with the tester is possible.

Note that the order in the procedure of the failure

diagnosis may be reversed to the example as described in

20   the embodiment (in which the diagnosis trouble code is

investigated after the resistance value of the CAN bus

main line 4 is measured). In other words, the resistance

value of the CAN bus main line 4 may be measured after the

diagnosis trouble code is investigated.

25   In the aforementioned embodiment, the failure

diagnosis method of a communication network related to the

vehicle stability control system for preventing lateral

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sliding is described. However, the failure diagnosis

method of the present invention is not limited to the

vehicle stability control system, and, needless to say, it

can be applied to other control systems that are mounted

5   on the vehicle.

Furthermore, in the aforementioned embodiment, the

CAN bus is described as an example of the multiplex

communication line, but it goes without saying that the

failure diagnosis method of the present invention can be

10   also applied to a communication network using the

multiplex communication line (the next generation

communication architecture such as TTCAN, TTP, FlexRay,

byteflight) other than the CAN bus.

While the above description is of the preferred

15   embodiments of the present invention, it should be

appreciated that the invention may be modified, altered,

or varied without deviating from the scope and fair

meaning of the following claims.